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Separation of *Chlorella* biomass from culture medium by flocculation with rice starch

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ABSTRACT

Coagulation-flocculation remains as one of the preferred methods for efficient harvesting of *Chlorella* sp. cells. Although the use of established aluminium salts is highly appraised for high harvesting efficiencies, excessive residual aluminium imparted on both the treated supernatant and harvested biomass remained worrisome. Hence, the objective of this present study is to minimize the resulting concentration of aluminium present in the system by evaluating the use of rice starch as an aid to chemical coagulants. The residual aluminium in the starch aided and non-aided treated supernatants and biomass were then determined by using an inductively coupled plasma-optical emission spectroscopy (ICP-OES) and energy-dispersive X-ray (EDX) spectroscopy respectively. At an optimum pH of 6, more than 95% of the initial *Chlorella* biomass was recovered at 72 mg/L of alum or 9 mg/L of PACl. However, high residual aluminium contents in treated supernatants (1.3–1.7 mg/L) and biomass (2.5–4.5% weight distribution) were evident. Through the introduction of autoclaved rice starch by up to 120 mg/L as an aid, the dosage of chemical coagulants applied and the detected residual aluminium concentrations were reduced by up to 54%. Despite the increment in organic loadings for these treated samples, the use of starch which is biodegradable would minimize the resulting toxicity and metal contamination imparted. Thus, rice starch can be considered as a potential alternative to lower the dependence on chemical coagulants which limits the reusability of culture medium. Based on the FE-SEM micrographs obtained, the resulting flocs treated with rice starch were notably filamentous and threadlike; in-line with the coagulation mechanism of adsorption and bridging.

1. Introduction

Photosynthetic microorganisms such as microalgae are prized sources of raw materials with diversified industrial applications [1,2]. At present, the microalgae market is greatly dominated by *Spirulina* and *Chlorella* with combined global annual production of 5000 t; amounting to 50% of the total worldwide algae production [3] with dedicated applications as health food and products [4]. Studies further present estimates close to 30% of the current global algae production being utilized for animal feed [3]. Other commercial uses of *Chlorella* include cosmetics and also aquaculture [5]. The small size (5–50 μm) and low microalgae density in the range of 1030–1140 kg/m^3 [6–8] complicate the harvesting process without the selection of a suitable treatment method. Efficient harvesting of microalgae therefore has been one of the prime focusses in recent years, with emphasis on various methods either of chemical, biological or physical nature [9]. Among these however, coagulation-flocculation is recognized as one of the promising and economical methods, also yielding the removal of intact microalgae cells [10]. Other merits of this method include the convenience handling larger amounts of algae culture for treatment [7,8], easily scalable and caters a wide range of microalgae species [11]. This further prompts the coagulation-flocculation method as a simple solution towards harvesting *Chlorella*.

Depending on the use of harvested biomass, the choice of coagulant should also be cautioned [12]. Inorganic coagulants such as aluminium and ferric salts are among some of the commonly used types [13]

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